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SOME SUGGESTIONS ON CARE IN THE USE AND HANDLING OF EXPLOSIVES IN COAL MINES

BY

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SOME SUGGESTIONS ON CARE IN THE USE AND HANDLING OF EXPLOSIVES IN COAL MINES[1]

By Lloyd G. Fitzgerald[2]

INTRODUCTION

The dangerous nature of explosives makes them a potential hazard wherever they are used, but they are likely to exercise their greatest harmfulness under conditions inherent in coal mining. The ease with which explosives can be detonated and the suddenness and violence with which they detonate require great care in their handling and use, if accidents are to be avoided. Campaigns have been waged by the manufacturers, the Federal Bureau of Mines, coal-mining companies, and other agencies to educate users of explosives in their dangers and in their proper use and care.

Probably 95 percent of the explosives accidents can be attributed to poor judgment, carelessness, negligence, or chance taking. In many explosives accidents it is difficult to determine the cause definitely, as the evidence of the origin is destroyed by the blast and frequently those involved have been killed. Survivors of the accident often are of little help in determining the cause, as the accident occurs so suddenly they cannot tell what happened or prefer not to divulge the information they have because it may reflect to their own carelessness.

A survey has indicated that about 10 percent of all fatalities in coal mines were caused by explosives accidents (excluding gas and dust explosions initiated by explosives). A list of explosives accidents by States, for the years 1925 to 1932, classified according to the severity of the accidents, indicated that Kentucky and Wyoming had the greatest number of fatalities resulting from explosives accidents. Records of the Bureau of Mines show

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that 14 coal-mine explosions occurred from January 1 to June 1, 1943. Explosives were involved in four of these explosions. Black powder caused two of the accidents and permissible explosives used in a nonpermissible manner the other two. These statistics are mentioned to show that explosives are still causing severe accidents.

Surface Storage

Elimination of the hazards associated with explosives begins on the surface. Storage magazines should have no opening, except for entrance and ventilation; ventilators should be screened effectively to prevent the admittance of sparks as well as to prevent unauthorized entrance. The interior should be kept clean and dry, and the floor should be of nonsparking material with no metal exposed. The surrounding area should be kept free of combustible material for not less than 25 feet (and preferably 50 feet) in all directions. Storage magazines should be fire-resistant and reasonably bulletproof.

In 1943 a 12-year-old boy was killed when he fired a small-caliber rifle into an explosives-storage magazine, causing the contents to detona This case demonstrates that the requirement for a bulletproof magazine is justifiable. At a mine in Idaho, during this year, 5 tons of explosives were unloaded from trucks at 9:30 p.m. and left near some mine building This was done in order that the regular crew on the day shift might place the explosives in the storage magazine and thereby save the expense involved if extra men were called to do this work. A guard was not left wi the explosives, and a fire originating in a nearby building later that night ignited them. The explosives detonated, causing damage exceeding $34,9 and injury to one man. This is another example of what may happen whe explosives are handled or stored carelessly.

Many coal companies, in complying with the instructions for storin handling, and transportation of explosives as outlined by the Explosives Control Division of the Federal Bureau of Mines, found that not only were explosives protected, but a considerable saving was made when explosive were stored in approved-type magazines. This saving was due to the fac that explosives did not deteriorate so rapidly in magazines that were well constructed, drained, and ventilated. Thefts of explosives were minimiz by the double locks and a checking system. One company that has devel mines in a comparatively low coal bed reported that an average of one cartridge of explosives was saved in each place blasted after it began ch ing explosives. Officials could check the explosives used in each place s discover where the blasting was inefficient. This saving was reflected n only in the cost of the explosives but in realization due to an increased quantity of coarse coal. This saving will be reflected in safety, as any

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method of mining that reduces the quantity of explosives used per ton of coal mined will tend to reduce the hazard due to the use of explosives.

Transportation

The hazard of transporting explosives into the mine can be minimized. Since 1926, millions of pounds of black blasting powder and dynamite have been transported from the manufacturing plants to the users, and according to statistics there has not been one death due to railway transportation of dynamite or black powder either in the United States or Canada. This record is due to strict observance of carefully drawn regulations and is evidence that explosives can be transported safely.

A similar safety record should be desired by every mine operator. To accomplish this, it is advisable to transport explosives and detonators in separate cars or in insulated boxes placed in ordinary mine cars. An insulated coupling should be used if the explosives trip is pulled by an electric locomotive, and an empty car should intervene between the locomotive and the explosives trip. If carried by individuals, explosives should be in separate containers constructed substantially of nonconductive material.

Types of Explosives

Virtually all permissible explosives now used are ammonium nitrate or gelatin explosives. Ammonium nitrate explosives deteriorate quickly when exposed to a damp atmosphere. If a cartridge absorbs moisture it may fail to detonate. The quantity of explosives transported into the mine at any one time should not exceed one day's supply; where feasible, explosives should be transported during the off shift or between shifts. In addition to these rules it is necessary to safely govern the handling of explosives under all conditions in the various mining operations.

The volume of sales of black blasting powder was smaller in 1938 than in any year since 1912, when sales figures were first reported by the manufacturing companies to the Bureau of Mines. However, the volume of sales increased for two succeeding years (1939 and 1940) but began decreasing again in 1941 and 1942. The previous low year was 1932. Approximately 89 percent of black blasting powder manufactured since 1932 was used in coal mines and coal production has increased yet the average annual sale of black powder has decreased. This would indicate that more coal-mining companies are using permissible explosives or blasting devices.

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The hazards inherent in blasting with black blasting powder are greater than from the use of permissible explosives because of the highe temperature and length of flame. In the past, when black blasting powder was used more extensively, about one-third of our coal-mine explosions were initiated by blown-out shots, and at least 90 percent of these were due to black blasting powder. During the first part of this year in a mine in a certain State a shot charged with black powder blew out, causing a local explosion that traveled 500 feet, seriously burning three men. Mor severe accidents where black powder was involved could be named; these have occurred in several States. The record as regards the responsibil for coal-mine explosions and explosives accidents by no means favors t use of black blasting powder. For this reason, only permissible explosi and blasting devices should be considered.

Permissible Explosives

A permissible explosive or blasting device is one that has passed certain tests conducted by the Federal Bureau of Mines at the Explosive Experiment Station. However, there have been serious accidents when permissible explosives were used in a careless or in a nonpermissible manner, such as adobe or mud-capped shots, stemming the borehole wit combustible material, firing shots in an explosive mixture of gas and ai or in a dusty atmosphere, firing holes that have been drilled beyond the confines of the cut or shear, using short blasting cables, firing shots in rapid succession, and other conditions that are conducive to explosives accidents.

Permissible explosives when fired in the open produce enough fla to ignite gas or dust. In an eastern State a serious coal-dust explosion was caused by the simultaneous firing of three adobe shots to break som fallen rock; the three shots were charged with a total of 2.6 pounds of p missible explosive and fired by means of current from the trolley wire.

A fire was caused in a Utah mine recently when a round of 10 sho each containing an average of more than 4 pounds of permissible explos was fired simultaneously with a nonpermissible 50-shot blasting unit. A first round of 15 shots had been fired just before the second round of 1 shots. The mine was naturally wet, which probably prevented an explo

Permissible explosives are manufactured in a wide range of dens (or stick counts). In fact, there is a suitable permissible explosive for virtually any blasting problem in any coal mine. The effect of an explo upon the material blasted, whether coal or rock, may be varied over wi limits by selecting the proper permissible explosive, by varying the nu ber, position, and diameter of the boreholes, and by utilizing the proper

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diameter and length of the charge of permissible explosive used. Usually explosives manufacturers will furnish a technical representative to assist in selecting the suitable permissible explosives.

When a borehole is charged with permissible explosive, the primer should be made with the electric cap secured centrally in the cartridge and pointing toward the bulk of the explosive in the cartridge. Most explosives experts believe that the primer cartridge should be the last placed in the hole, with the detonator pointing toward the bulk of the charge and the bottom of the hole. Experiments have shown that if a blown-out shot occurs the danger of igniting inflammable gas or dust is more remote than if the primer is placed anywhere else in the charge. Some explosives experts now hold that the primer cartridge should be the first stick in the hole rather than the last one. The charge should be pushed as a train with a wooden tamping stick toward the back of the hole and the borehole then stemmed full to the collar with incombustible stemming; this procedure should be followed whether the primer stick is the first or the last to be placed in the borehole. The blasting cable should be at least 100 feet in length and should have the wires at the firing end staggered at least 6 inches to prevent the bare ends of the wires from making contact and causing a misfire. In gassy mines a test should be made for gas before and after blasting. The cable should be unwound to a place of safety and ample warning given before the terminals are applied to a permissible battery. The blasting cable should be wound up after each shot or supported on timbers or ribs so as to be protected from stray currents and electrically energized agencies.

The source of stray currents is sometimes more or less a mystery, for they have been detected in mines where no mechanically generated electricity was in use. There appears to be a possibility that such currents may be generated chemically in the ground or conducted from remote fields. Experiments have shown that a difference of potential between the lead wires of 0.75 volt and a current of 0.34 ampere will explode an electric detonator. In mines using mechanically electrified equipment considerable current is dissipated into the ground, and a difference in potential might be detected between the rail and floor, between a mine car and the rib, and at many other places. Miners should be educated to regard every surrounding surface as a probable source of blasting power and isolate or insulate the bare ends of detonators and lead wires accordingly.

Cardox

To produce coarse coal and at the same time have the coal at the face pushed forward to facilitate mechanical loading, some companies use the

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permissible blasting device Cardox. This device is not actually an explosive but is used in blasting coal and has caused enough accidents to merit discussion in this paper.

Although records in recent years do not show ignitions due to the use of Cardox, nevertheless it has inherent hazards. In relatively hard coal the hazard most discussed is the flying shell. Practically all accidents investigated that were due to flying shells revealed that the borehole was placed improperly and that the shot firer and others involved were not around two right-angle corners. One company reported that it practically eliminated flying shells in its mine by the use of a sprag pipe inserted in a borehole drilled about 30 inches deep and intersecting the regular borehole at an angle of about 30°. This company joined with the Bureau of Mines in making tests to see if this device would confine the shells within the boreholes under extreme conditions, such as in holes drilled on the solid and when the discharge caps were cut off. There were some failures under these extreme conditions, but it was found that with a substantial sprag pipe and under normal conditions the shell usually was confined to the vicinity of the face. Even with this sprag-pipe-holding device this company has the rule in effect that when firing Cardox the shot firer must see that all persons are in the clear and get in a safe place himself. When Cardox is being fired everyone should be 100 feet or more from a Cardox shot and, if possible, have two or more intervening corners between him and the shot.

Cardox shells should be wired only at the working faces and away from the track or other electrical equipment. The leg wires shoud be removed from all misfired, discharged, or loaded shells. The misfired shells should be handled as loaded shells and returned to the charging plant in insulated cars or in insulated boxes placed in ordinary mine cars. Other precautionary measures should be taken in transporting and blasting with Cardox, but these are mentioned because accidents have happened when such rules were violated.

CONCLUSION

All the hazards inherent in the use of explosives and blasting devices have not been listed in this paper, but they are generally well known, and rules have been devised to guard against them; yet, despite rules and regulations, explosives accidents occur far too frequently. The more one knows about a particular hazard, the more respect he should have for that particular hazard. It would appear that there has been a failure to impress the users of explosives and blasting devices in the coal-mining industry sufficiently with the seriousness of the hazards connected with their use.

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One of the first duties of an operating company is to draw up a code f rules and standards to guide officials and employees. Those relating to ...sing should embody the best practices as regards safety and the pro- ...tion of marketable coal. It is often difficult for a section foreman to ...pervise each phase of work on his section; as human carelessness is a ...ge factor in the cause of explosives accidents, it would follow that the ...er the men who handle and use explosives, the fewer the accidents that ... occur. If competent shot firers are employed, this method provides ...ser supervision than can be had when miners and loaders fire the shots ...n minimizes the chances of shots being fired in violation of company ...es or State laws.

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